An Overview of Small Wind Systems

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Bergey Windpower Co.

A World Leader in Small Wind

- BWC Established in 1977
- Manufactures Small Wind Turbines Rated at 1, 1.5 and 10 kW (6 & 50 kW in development)
- Serve Consumer, Commercial, and Industrial Markets
- ~2,100 Installations, Covering All 50 U.S. States and 90 Countries
- 250 U.S. and 70 Foreign Dealers
- Licensee in Australia (Venco) and Subsidiary in China (Beijing Bergey Windpower Ltd.)

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The Last One Left Standing

- BWC Faced 45 Competitors in the 70's & 80's
- Gained Leading Market Share in 1983
- BWC is the Sole Survivor from the Last Energy Crisis
- The Difference:
  Better Technology:
  Product Ruggedness & Reliability

Popular Science, July, 1982

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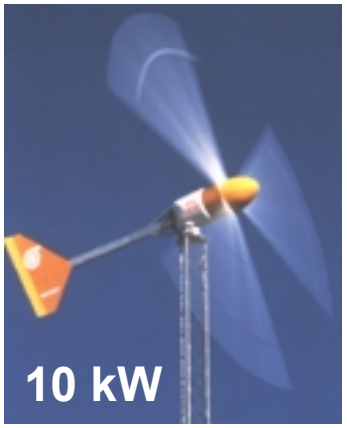
Modern Small Wind Turbines:

High Tech, High Reliability, Low Maintenance

- Products from 400 W – 50 kW
- Technically Advanced
- Only 2-3 Moving Parts
- Very Low Maintenance Requirements
- Proven: Thousands of Grid-Connected Systems Since 1980
- American Companies are the Market and Technology Leaders



(Not to scale)

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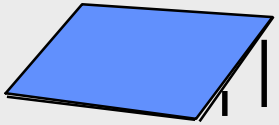
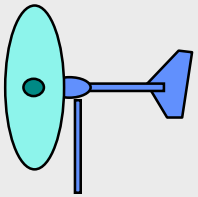
Wind has the Lowest Costs

Less Than ½ the Cost of Solar

Status of the Technologies	 Photovoltaics	 Solar Thermal	 Small Wind
Status	Commercial	Demo	Commercial
Installed Cost	$ 9 / Watt	$ 10 / Watt	$ 3.50 / Watt
Payback Period	30 Years	30+ Years	15 Years
Cost Potential	$ 3 in 2010	?	$ 1.50 in 2010
Typical Site	Suburban	Southwest	Rural
Available Resources	Poor - Good	Poor - Good	Poor - Great

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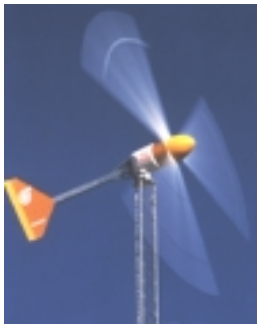
More Expensive, but Also More Valuable

Large Turbines

- ~ $1,000 / kW
- High Voltage Delivery
- Value of Power:

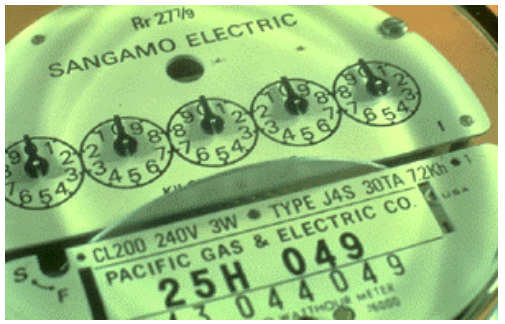
2 - 6¢



Small Turbines

- ~ $3 – 4,000 / kW
- Low Voltage Delivery
- Value of Power:

6 - 26¢



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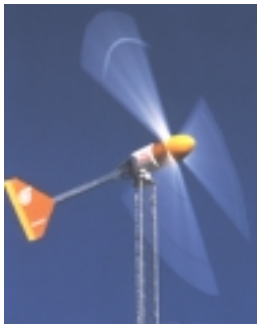
Small Turbines Require Less Wind

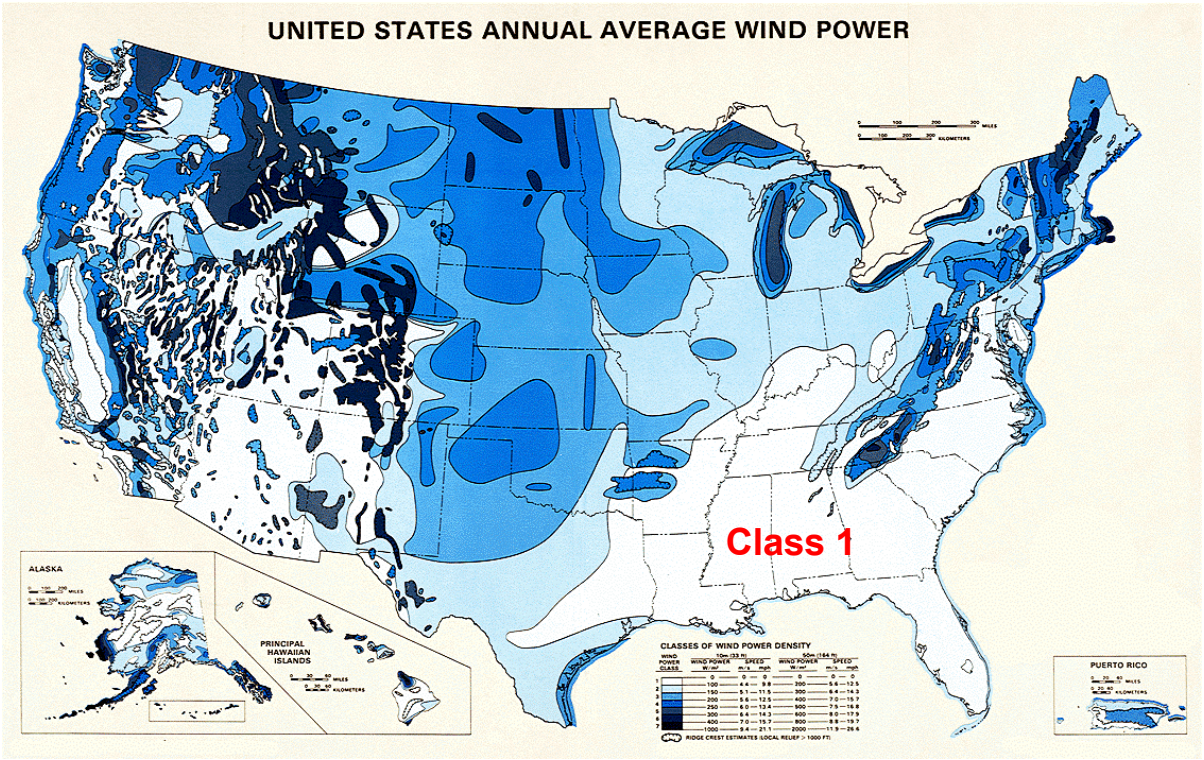
Large Turbines

- Require ~ Class 3-4 Wind Regime
- Prefer Class 5



Small Turbines

- Require ~ Class 2 Wind Regime



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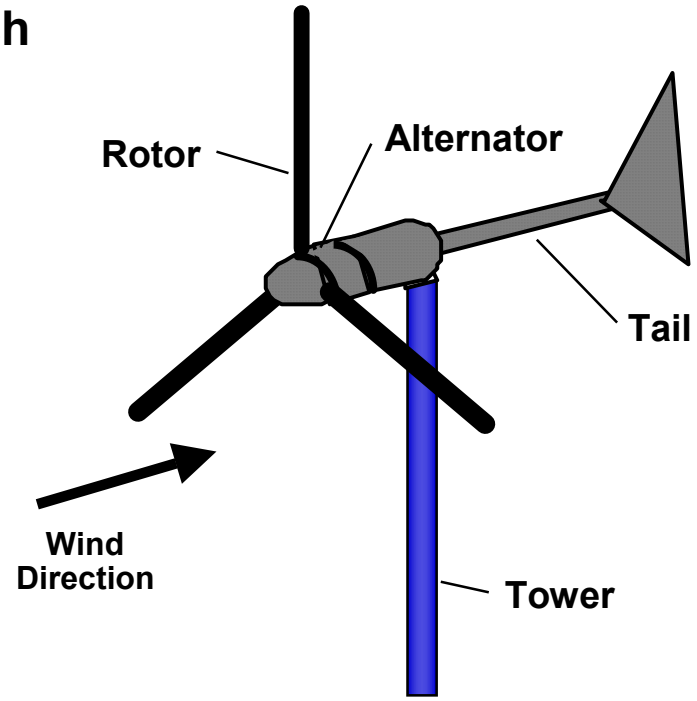
Generic Small Wind Turbine

- Horizontal-Axis, Up-Wind Configuration
- 2 or 3 Blade Rigid Rotor - Fixed Pitch
- Special Direct Drive Generator, Usually Permanent Magnet Type
- Tail Aligns Rotor to Wind
- Passive Overspeed Protection by Furling, Either Up or to Side
- No Mechanical Brake ... Shutdown with Electrical Braking
- Yaw-Axis Slip-Rings
- Mechanically Simplicity ... Few Moving Parts



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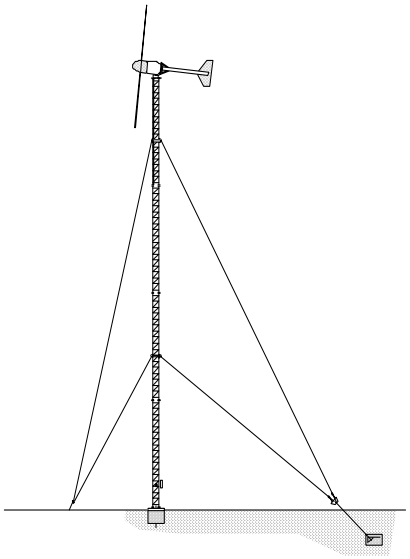
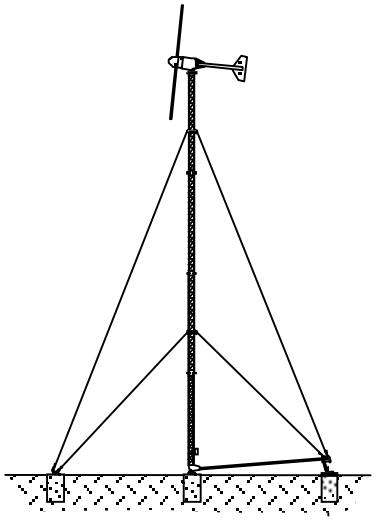
System Components:

Towers – Numerous Options

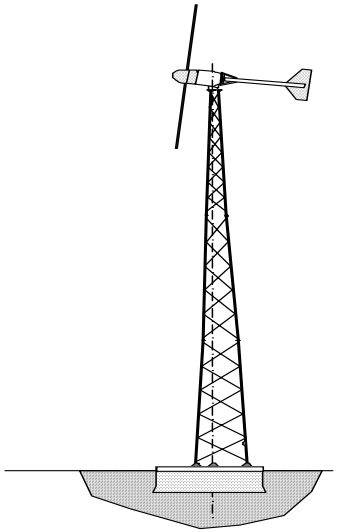
Towers of 18 - 37 m (60 - 120 ft) Recommended for Most Situations



Guyed-Lattice



Guyed Tilt-up



Self-Supporting Lattice

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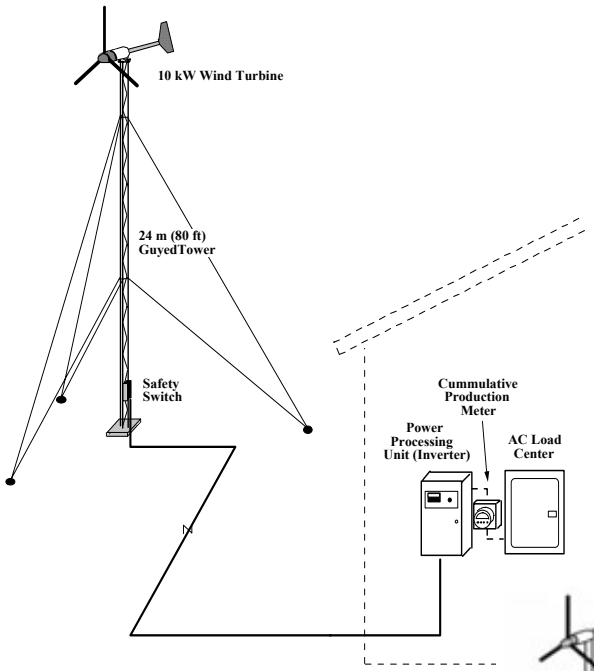
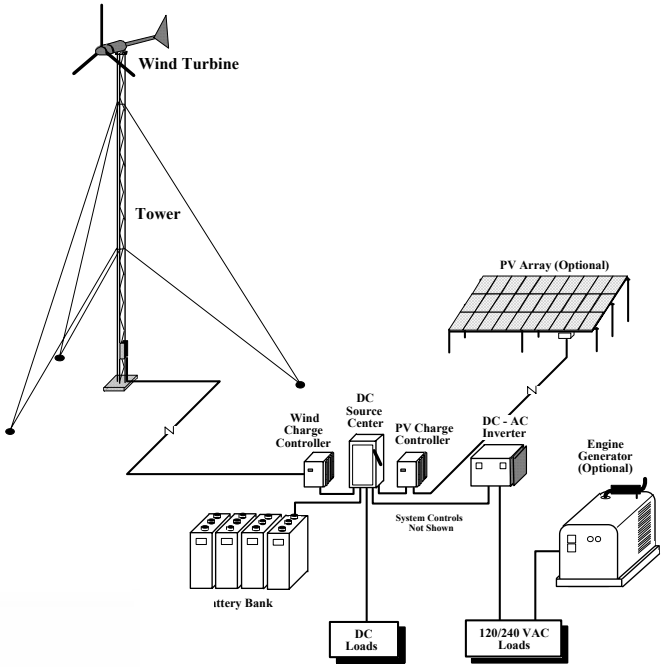
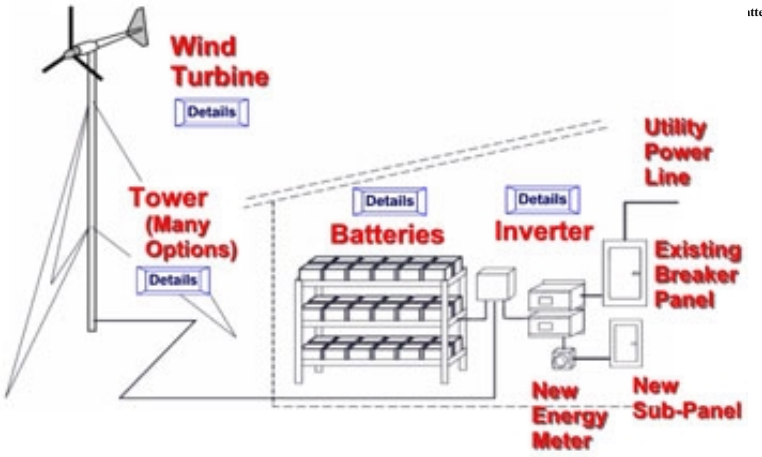
Electrical Architectures



Grid-Intertie



Off-Grid



Intertie + Back-up

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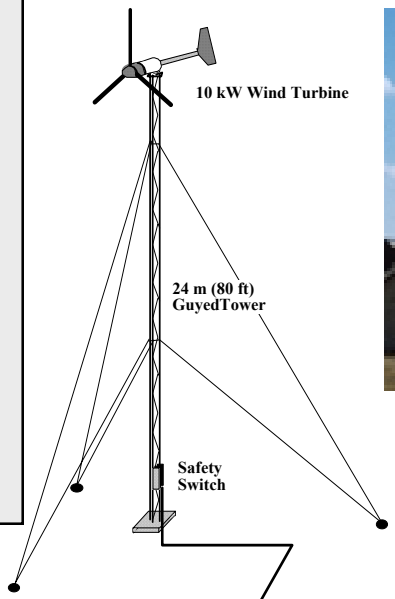
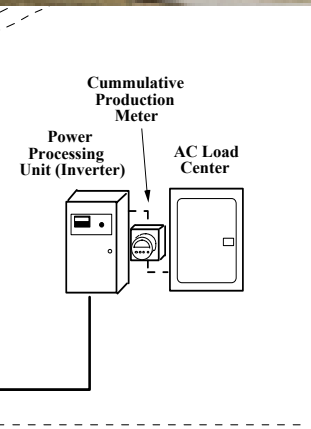
Rural Residential Wind

TYPICAL HOME SYSTEM

- 10 kW (21 ft. Rotor Diameter)
- Rural Site, 1 Acre or More
- Connected to House Wiring
- Produces ~ 13,000 kWh per Year
- Offsets ~ 7 Tons of CO_2 per Year
- Excess Power Sold to Utility (PURPA)
- Either Net Metering or Very Low Buy-Back Rate
- Cost: ~ $32,000 - $40,000





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People Want Wind Turbines for Their Homes

"Please give me something that will lower my electric bills, will help the environment and that I can afford"

91% of Americans support tax incentives for renewable energy

CNN/USA Today Poll, May 9, 2001

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The 64 mpg SUV

Residential Wind Turbine:

Remedy for "Soccer Mom's Remorse"

19,700 Lbs

+

-15,700 Lbs

=

4,500 Lbs

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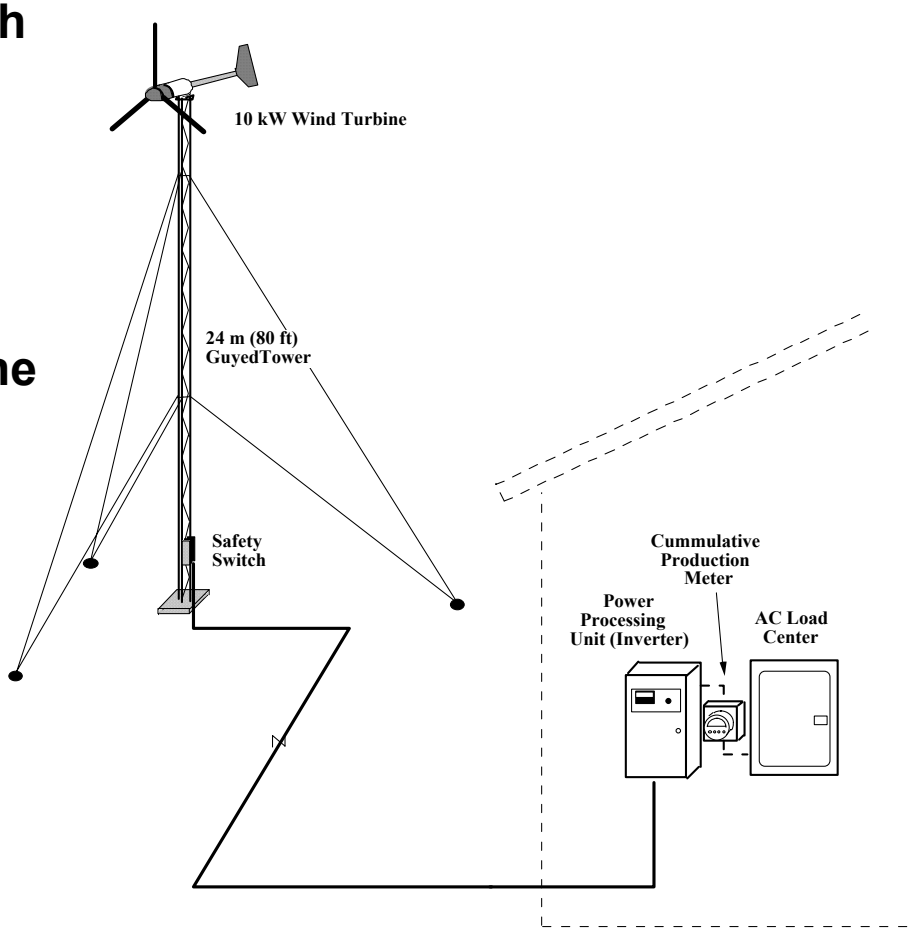
Annual CO_2 Emissions

Grid-Intertie System

- Variable Speed Wind Turbine, with Inverter
- No Batteries
- Grid-Connect Through Dedicated Breaker in AC Load Center
- Simultaneous Supply from Turbine and Utility … Not “Either or”
- Turbine Production Reduces Purchase of Utility Power
- Excess Production Sold to Utility
- System Shuts Down During Outage
- Easily Retrofitted to Existing Facilities



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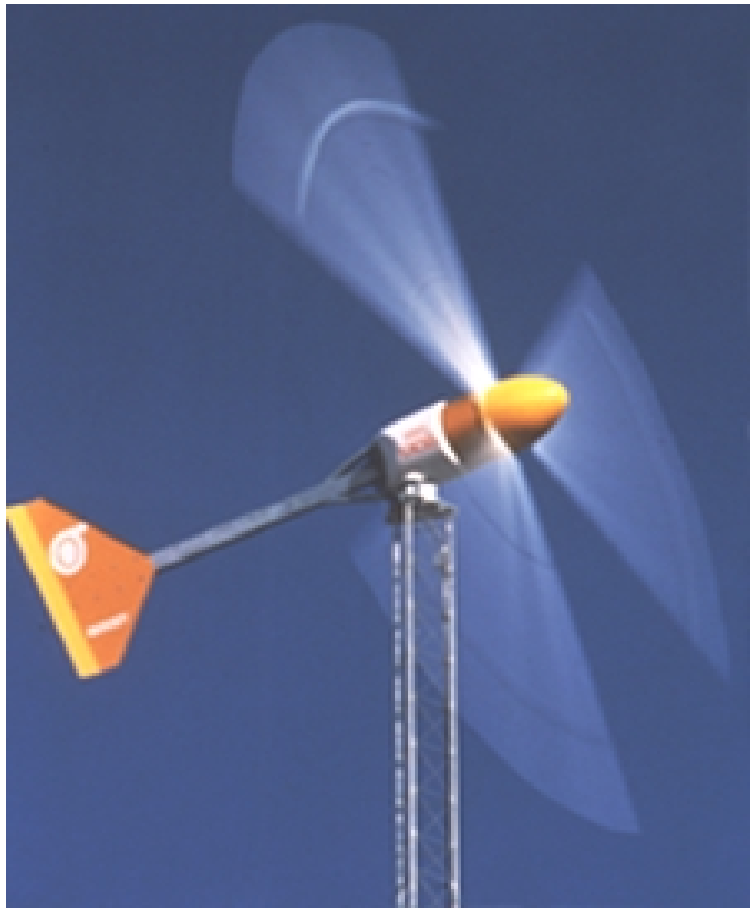
System Components:

Wind Turbine – Bergey Excel-S

- Rated at 10 kW at 30 mph
- 20 ft. Diameter Rotor
- ~ 700 Installed
- ~ 80% Market Share in the 5 – 15 kW Size Range
- 5 Year Warranty (Industry's Longest)
- New Blade System for 2001



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System Components:

Inverter – Bergey GridTek 10

- Grid-Intertie Inverter for the 10 kW BWC Excel Wind Turbine
- Manufactured by Trace Technologies
- IGBT / DSP Digital Design
- Standards: UL 1741, IEEE 929, IEEE 519
- UL Certified

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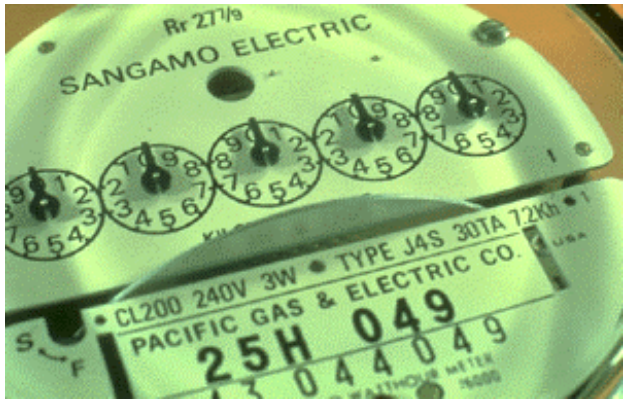
Interconnection

- Industry Experience: 300+ Million Operating Hours at Thousands of Sites
- Utility Interconnection Agreement Required
- PURPA 210, Qualifying Facility
- State Implementation Rules Differ
- Net Metering (Energy Banking) for Small Systems in ~ 30 States
- Emerging UL and IEEE Standards for Safety and Power Quality



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Permits

- Building Permit Usually Required
- Industry Design Standards Exceed Building Code Requirements for Wind Loading
- Height Restrictions are the Most Common Problem: 35 ft. in Many Areas
- Need 80 – 120 ft Towers
- Neighbor's Concerns: Noise, Aesthetics, Property Values … NIMBY & Neighborhood Politics

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Example from Active Market Area

- Residential System
- Kern County, California
- Moderate – Good Wind Resources
- Southern California Edison: ~21 cents per kWh
- Net Metering, Annual Period
- 50% Rebate Available under System Benefits Fund

10 kW, Tehachapi, CA

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10 kW System Costs

Item	Description	Price
1	EXCEL-S Wind turbine & Inverter	$20,900
2	100 ft GL Tower Kit	$6,900
3	Tower Wiring Kit	$930
4	Shipping & Delivery	$1,000
5	Foundations	$1,000
6	Wire Run (300 ft)	$900
7	Electrical Contractor	$650
8	Turbine Set-Up (Including Crane)	$950
9	Misc. Costs	$500
10	Building Permit	$400
11	Sales Tax (7.25%)	$2,033
	Total:	**$36,133**

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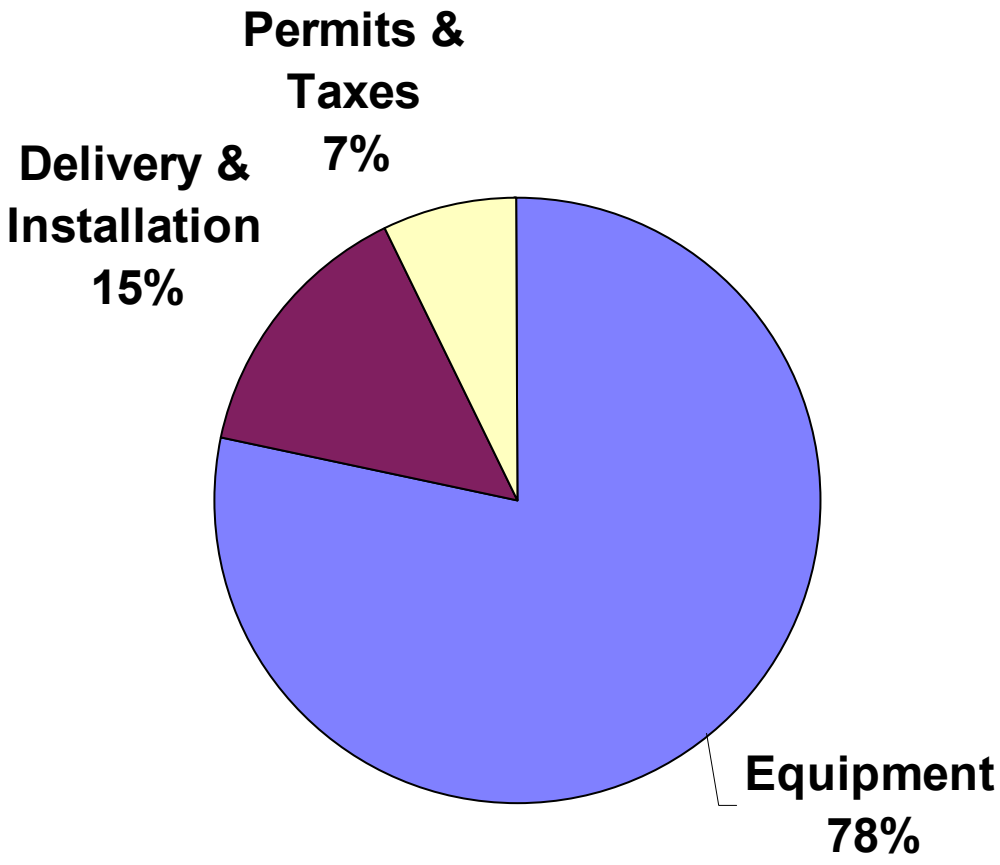
Cost Breakdown



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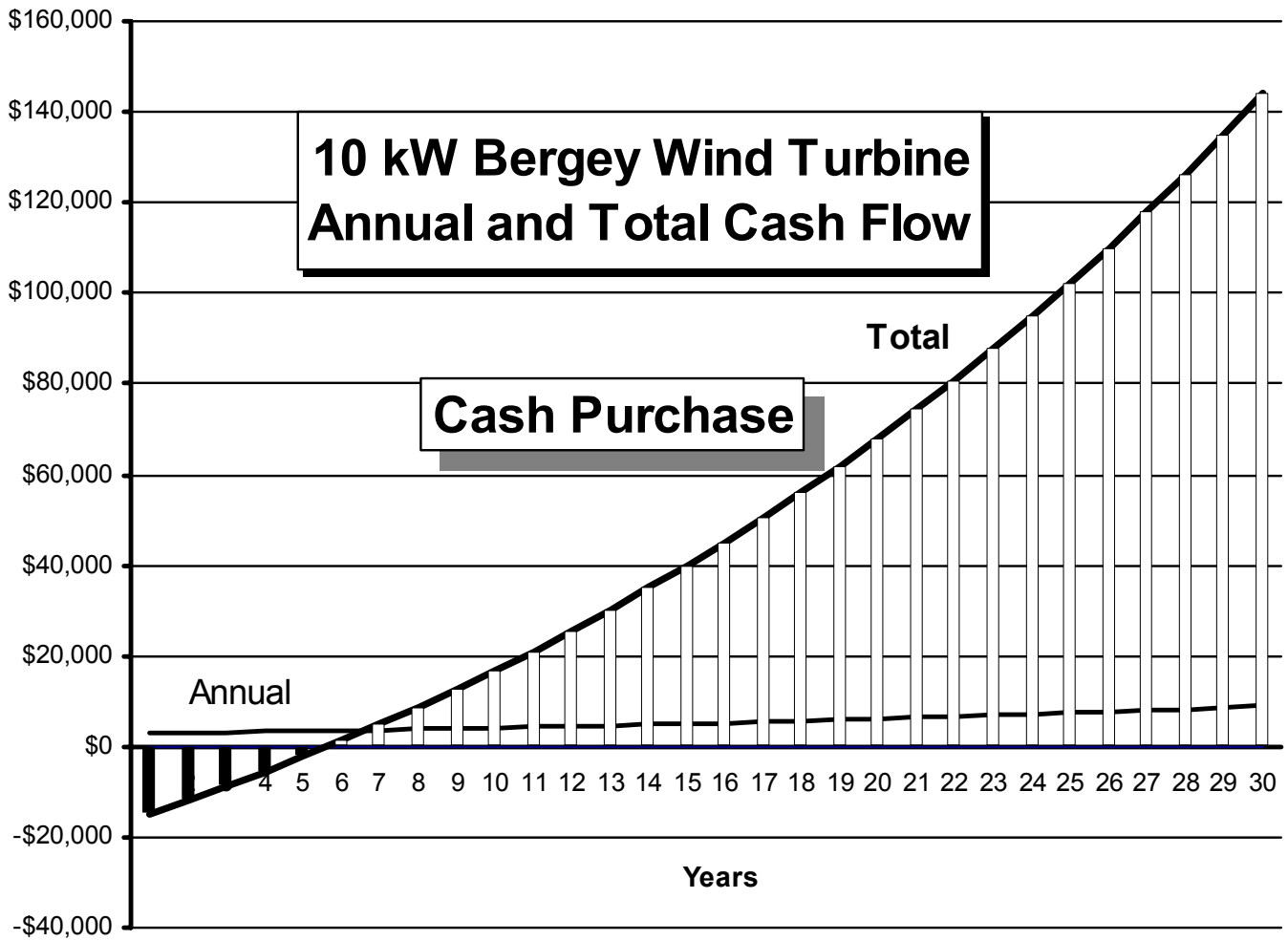
Economics - California



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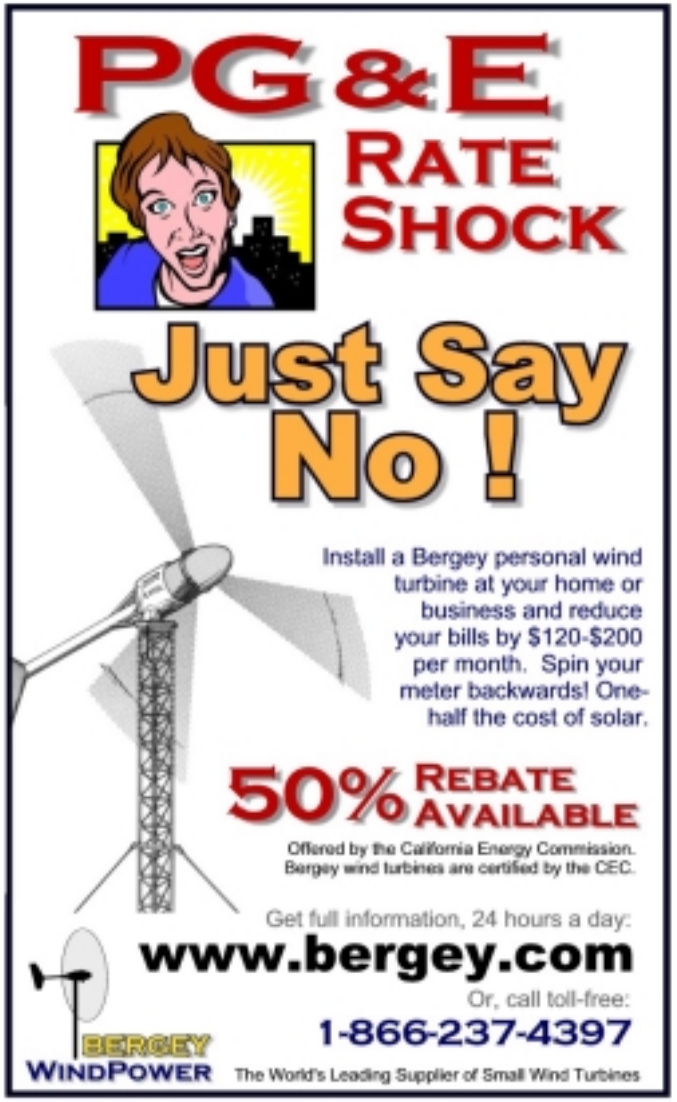
California Sales are Exploding

- 50% CEC Rebate for up to 10 kW Wind Turbines
- Electric Rates have Increased up to 80% (26 cents/kWh for usage over 3 x baseline)
- BWC has Tripled Production Since First of the Year
- Zoning Issues are the Only Bottleneck



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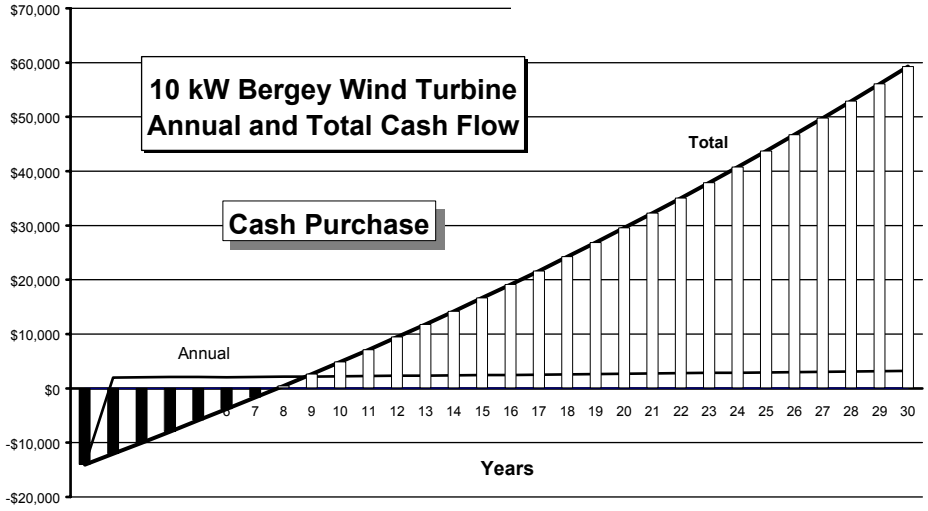
Domestic Market: It's Back!

- State Rebate / Buy-down Programs are Reviving the Rural Residential Market
- Growing Consumer Interest in Clean Energy and Self-Generation

50% Rebate

50% Grant

60% Rebate in NJ



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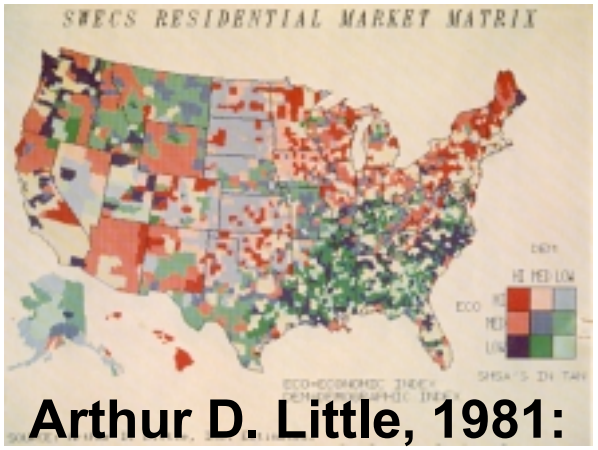
U.S. Market Potential: It's Big!

- Residential Electricity Consumption Exceeds Either Commercial or Industrial (35% of U.S. Sales in 1998)
- 20.6 Million Homes have 1 Acre or More
- 30.4 Million Homes have ½ Acre or More
- 4.6 Million Commercial Buildings
- Estimated 60% are in Class 2+ Winds



Arthur D. Little, 1981:
3.8 Million Units

Market Potential: 4 - 8 Million Units by 2020

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Barriers to the Market

Why Aren't There More Small Turbines

- Economics: Low Production Volume & Historical Lack of Subsidies = High Costs
- No Federal Tax Incentives
- Public Apathy Towards Energy
- Zoning: 35' Height Restriction
- No Real US-DOE Small Wind Program

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Programs and Policies to Nurture the Rural Residential Market

- Establish Rebate or Grant Programs Under Utility Restructuring (System Benefit Charge), Like California, Illinois, and New Jersey
- Create State Tax Credit Programs, like North Carolina
- Sales Tax Exemption
- Allow Net Metering, with Annual "Banking" Period
- Set Reasonable Interconnection Requirements
- State Zoning Regulation or Model Ordinance
- Property Tax Exemption
- Focus on Market Development First, R&D Second

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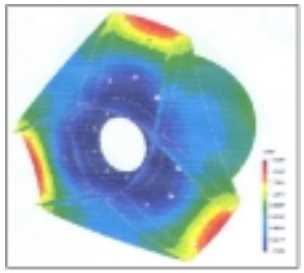
New Technology is Lowering Costs

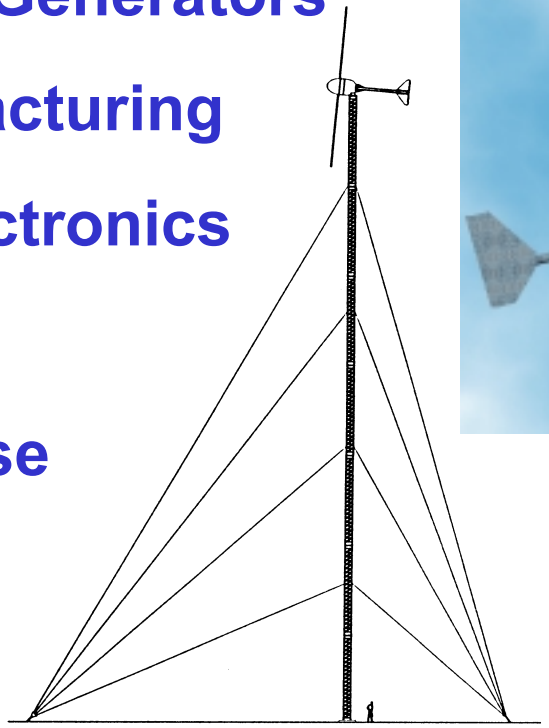
US-DOE Advanced Small Wind Turbine Program + Industry Funded R&D

- Advanced Airfoils
- "Super-Magnet" Generators
- Low Cost Manufacturing
- Smart Power Electronics
- Very Tall Towers
- Stealth: Low Noise



3D Solid Modeling

Bergey 50 kW



Windlite 10 kW

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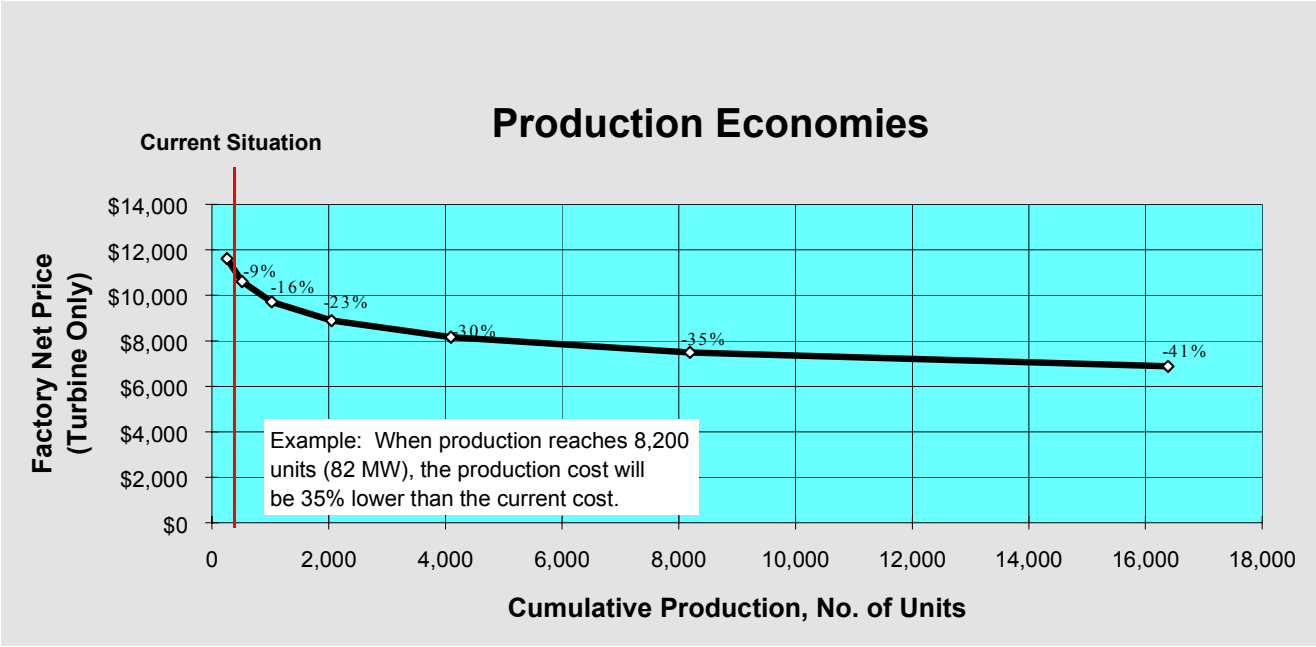
Volume Production will Lower Costs



Small Wind is a New-Age Home Appliance … "a ceiling fan on steroids"

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Sources for Further Information on Small Wind

- American Wind Energy Association, Washington, DC
  www.awea.org or 202-383-2500
- Bergey WindPower Co., Norman, OK
  www.bergey.com or 405-364-4212
- US-DOE National Wind Technology Center, Boulder, CO
  Ms. Trudy Forsyth: 303-384-6932

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